

# Visual Detection Thresholds of Walleye Under Varying Turbidity

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## INTRODUCTION

- Increasing anthropogenic turbidity in Lake Erie could alter the visual ecology of Lake Erie Walleye (*Sander vitreus*).
- Inorganic sedimentary turbidity is intensifying as a result of increased severity of storms, increased runoff, and other disturbances<sup>1</sup>. Organic algal turbidity is intensifying as a result of increased nutrient loading from agricultural and urban management processes<sup>1</sup>.
- Turbidity in the water column decreases light penetration as a result of amplified light scattering<sup>2</sup> and could promote a shift in the visual spectrum<sup>3</sup>.
- Fluctuating turbidity can alter visual sensitivity, or the ability of an animal to distinguish between an object and its background.
- Visual detection thresholds can be experimentally determined using the optomotor response, an innate response by an animal to visually follow a moving stimuli<sup>4,5</sup>.

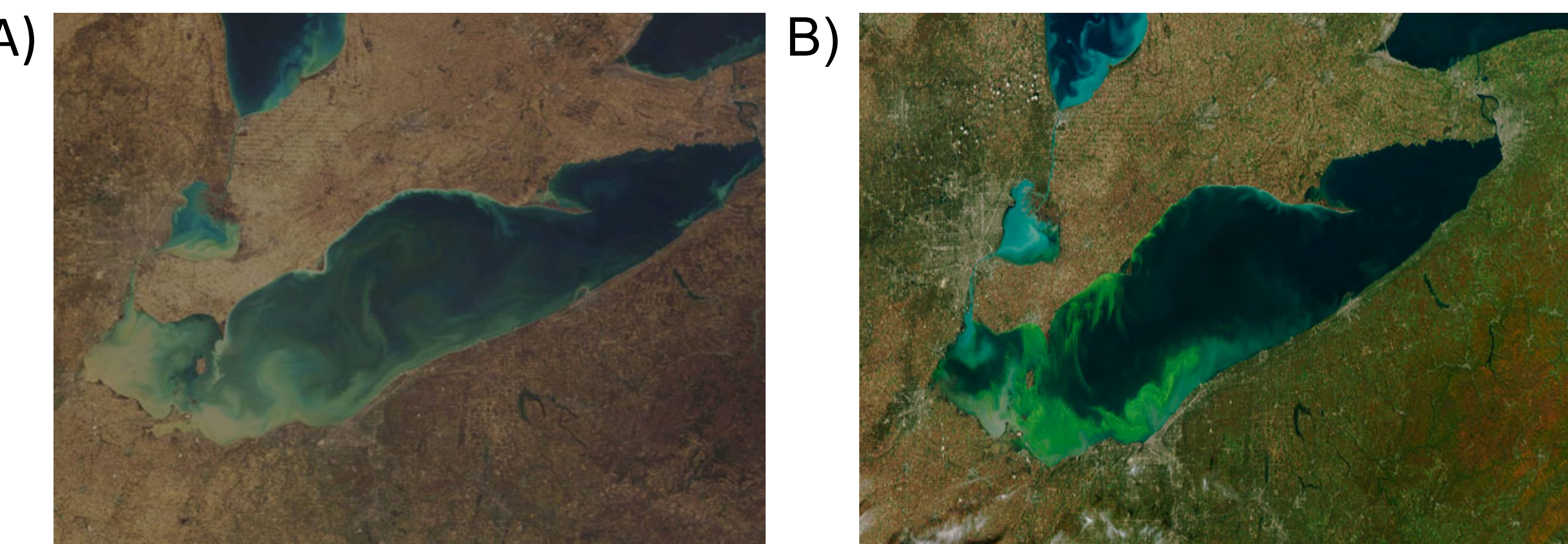
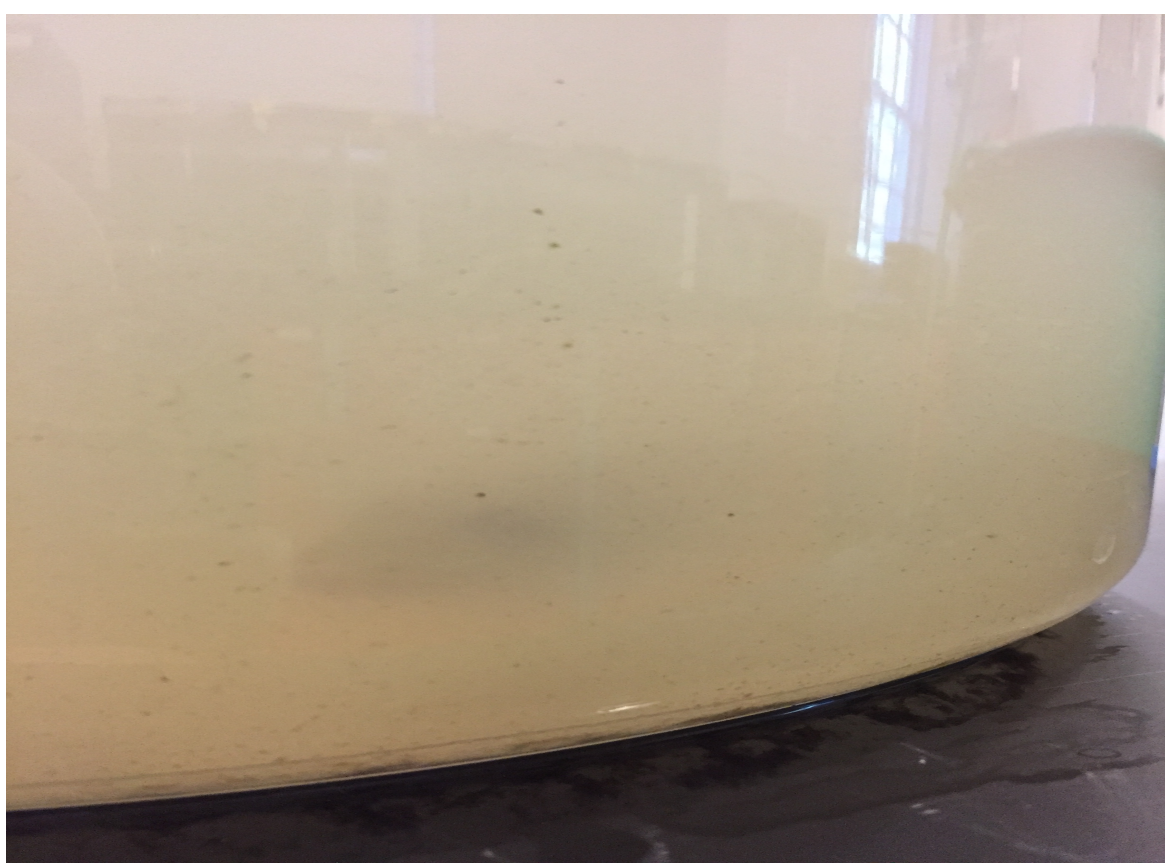


Figure 1A) Lake Erie sediment plume pictured on April 15<sup>th</sup>, 2005. Figure 1B) Lake Erie algal bloom pictured on October 9<sup>th</sup>, 2011. Photos courtesy of NASA.

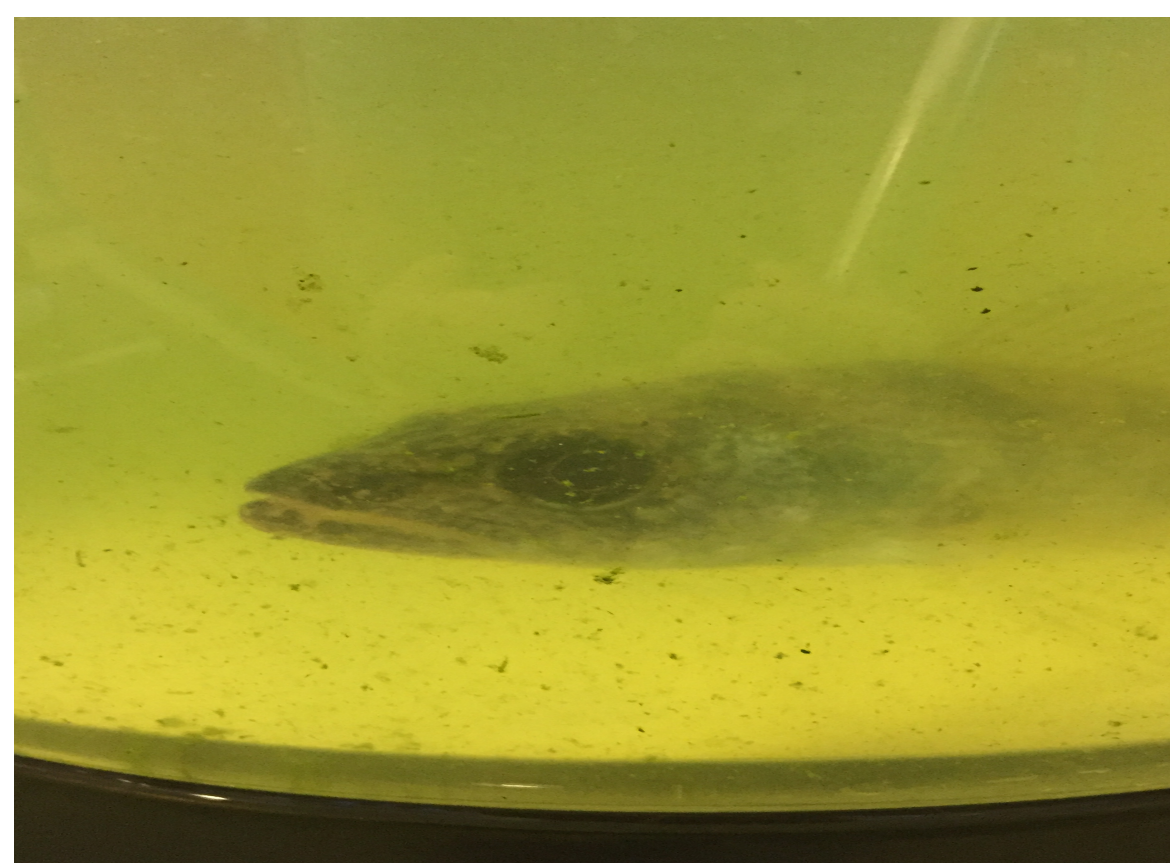
## OBJECTIVES

- To determine if the visual sensitivity of Walleye is altered by sedimentary and algal turbidity.
- To determine if varying turbidity types differentially influence visual sensitivity of juvenile and adult Walleye.

### Sediment



### Algae



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Figure 2) Predicated that visual sensitivity would differ under sedimentary and algal turbidity.

## METHODS

- Walleye were collected from trawls throughout the Western Basin of Lake Erie in the summers of 2017 and 2018.
- Optomotor response tests were used to establish visual detection thresholds for two different types of turbidity (e.g. algal and sedimentary).
- Adult (n=10) and juvenile (n=6) Walleye were tested twice under each treatment in which a random trial sequence was used.
- Following a 15 min. acclimation period, and only if the fish was following the screen, 4 NTU turbidity steps were incrementally added to the water.
- The turbidity step at which the Walleye was unable to follow the screen was recorded as the visual detection threshold.

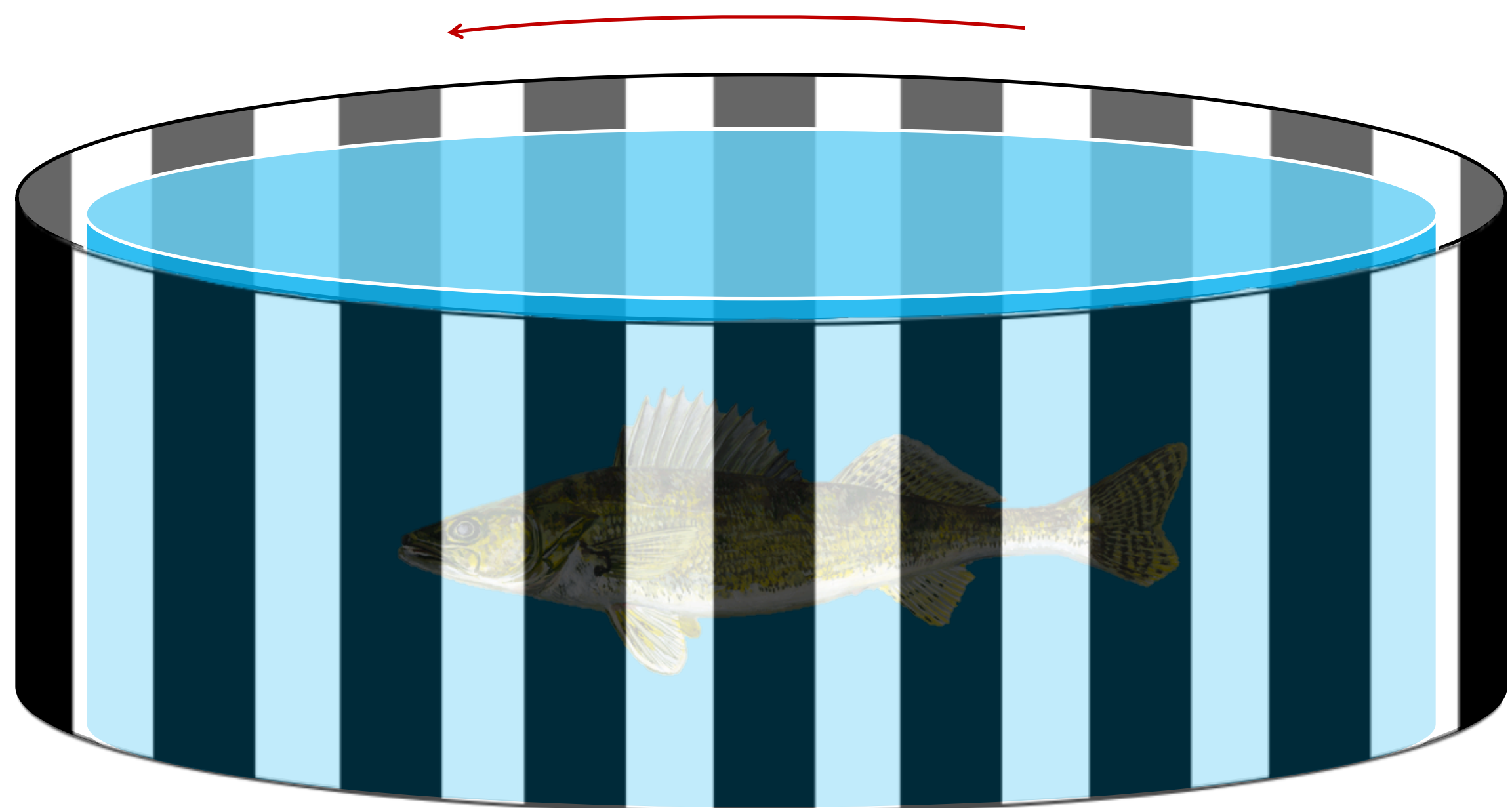


Figure 3) Optomotor response trials were completed in a cylindrical tank (100 cm diameter for adults; 40 cm for juveniles). The optomotor screen rotated at 12 rotations per minute (Nieman C.L., Oppliger A.L., McElwain C.C., Gray S.M. 2018).

## RESULTS

- Visual Detection thresholds in sedimentary treatment were significantly different than thresholds in algae treatment with standard length as a covariate ( $F_{1,28} = 53.04$ ,  $p < 0.001$ ; Fig. 4).
- T-test analysis between juvenile and adult Walleye detection thresholds within treatment was not significant (Algae;  $DF = 12$ ,  $t = -1.06$ ,  $p = 0.291$ ; Sediment;  $DF = 12$ ,  $t = -1.73$ ,  $p = 0.105$ ).
- Linear regression comparing detection threshold and standard length within treatment was not significant (Algae  $F_{1,30} = 1.987$ ,  $p = 0.169$ ,  $R^2 = 0.031$ ; Sediment  $F_{1,30} = 2.524$ ,  $P = 0.123$ ,  $R^2 = 0.047$ ; Fig. 5).

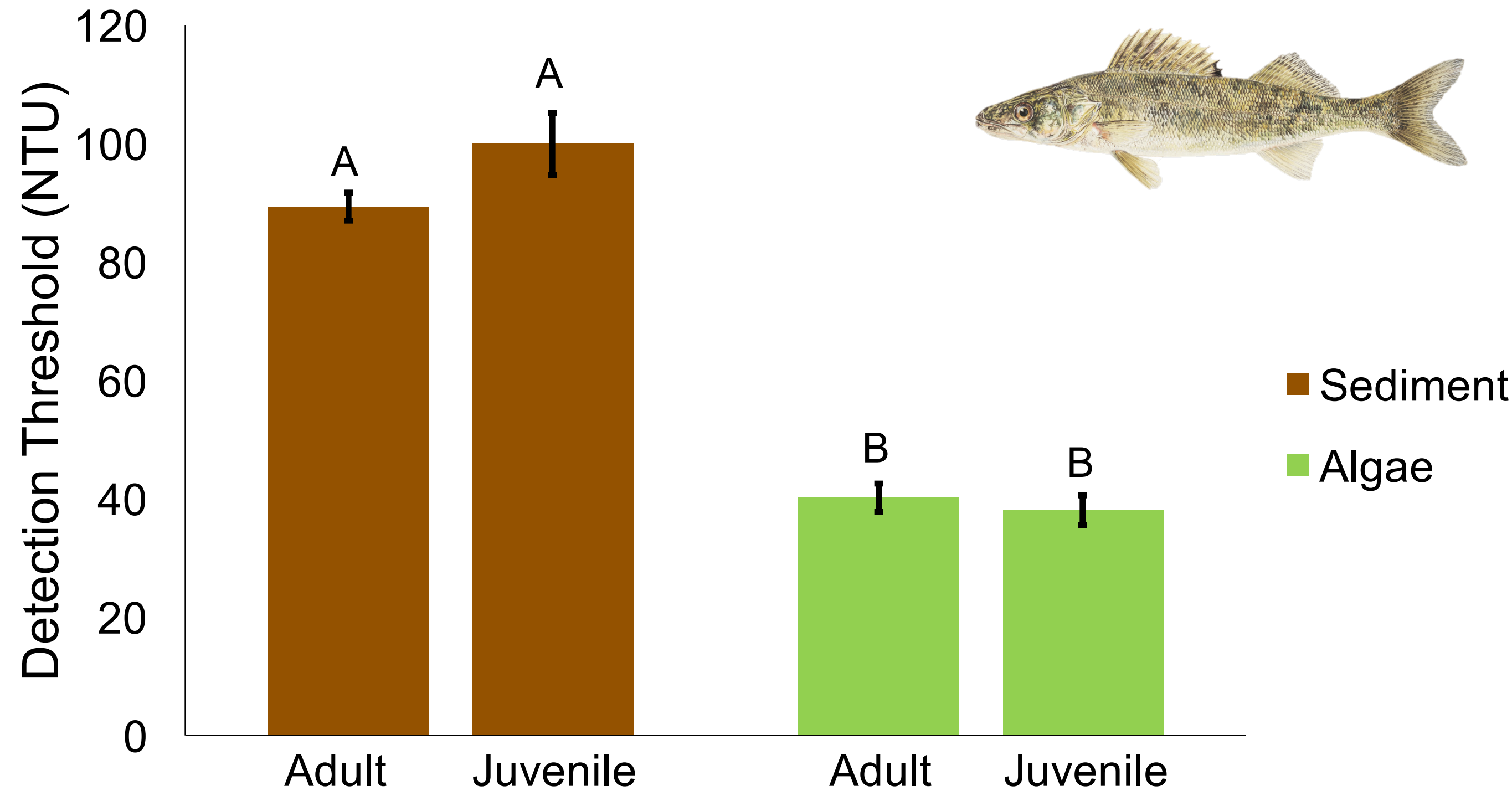


Figure 4) Mean ± SE detection thresholds of adult and juvenile Walleye (n=16) were experimentally determined for sedimentary and algal turbidity.

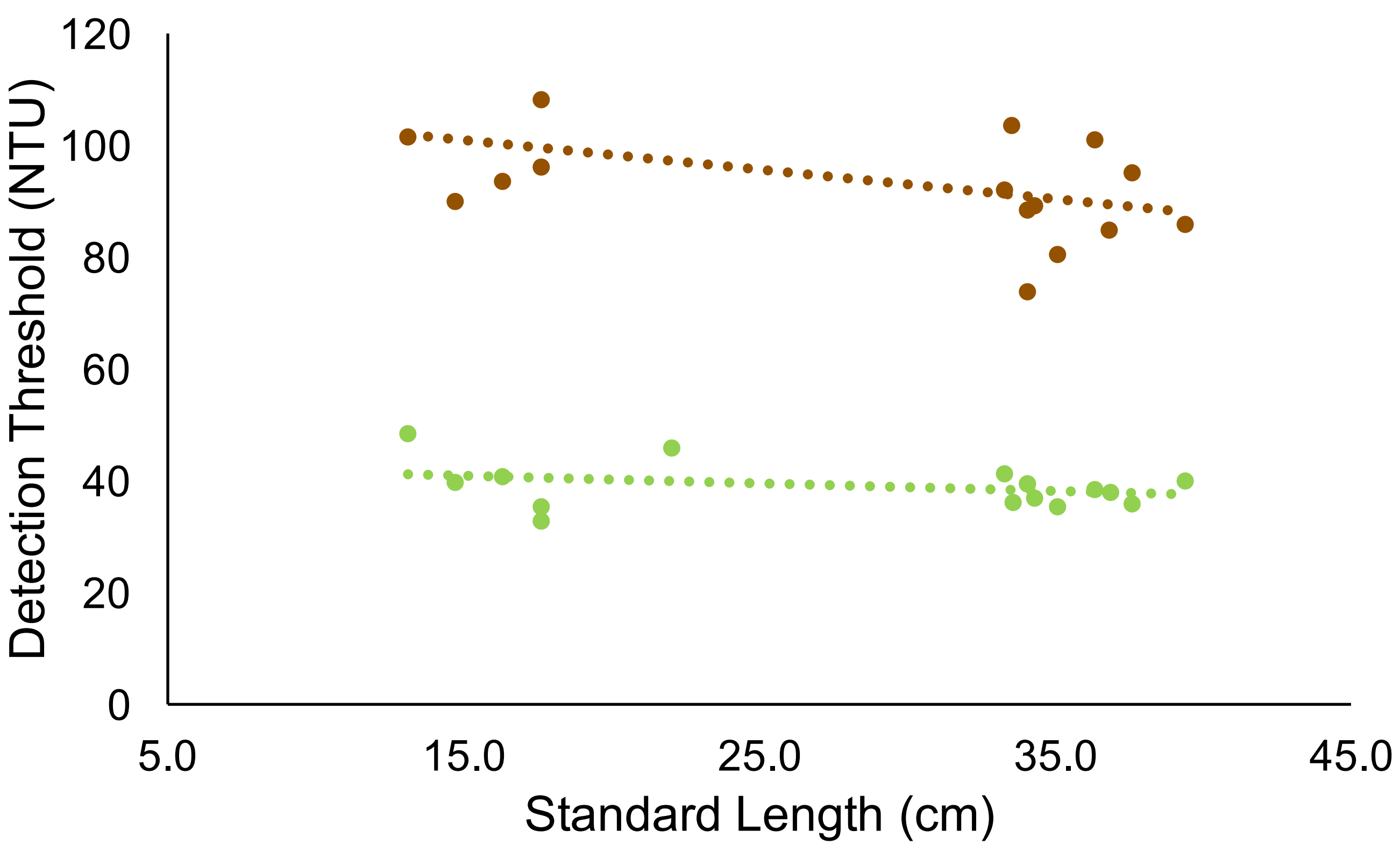


Figure 5) Linear regression comparing detection thresholds and standard length within treatment.

## DISCUSSION

- Results indicate variation in the visual sensitivity of Walleye across both treatment types.
- Visual detection thresholds in sedimentary turbidity were more than double that of algal turbidity with no significant difference between juvenile and adult Walleye.
- Understanding the potential impacts of changing turbidity levels on the visual ecology of Walleye allows us to understand the dynamics of how Walleye populations may behaviorally respond to increasing anthropogenic turbidity.

**REFERENCES:** 1. Michalak AM, Anderson EJ, Beletsky D, *et al.* (2013) *PNAS*. 110(16): 6448-6452. 2. Gray SM (2016) In *Encyclopedia of Soil Science, Third Edition* (3rd ed.). Taylor & Francis. 3. Radke RJ, Gaupisch A (2005) *Naturwissenschaften*. 92(2):91-94. 4. Wellington CG, Mayer CM, Bossenbroek JM, Stroh NA (2010) *Journal of Fish Biology*. 76(7):1729-1741. 5. Maan ME, Hofker KD, van Alphen JJM, Seehausen O (2006) *The American Naturalist*. 167(6), 947-954. 6. Nieman CL, Oppliger AO, McElwain CC, Gray SM (2018) *Conservation Physiology* 6(1), DOI:10.1093/conphys/coy044.

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